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## Description

## BACKGROUND OF THE INVENTION

5 The present invention relates to a process for producing fuel oil and gas by cracking waste rubber, comprising the use of a suitable catalyst, under specific temperature and pressure conditions, to crack the waste rubber so as to produce fuel oil and gas, and in the process, recycle the waste rubber.

In industry, rubber products are widely used owing to their unique properties. Furthermore, the rubber industry is well developed world-wide, and non-biodegradable waste rubber is accumulating and has become a pollution problem. Although there are many existing processes for treating waste rubber, the most common process is to crack waste rubber with a suitable catalyst under selected conditions, because it can produce useful fuel oil and gases while avoiding the secondary pollution problem. US Patent 4,108,730 describes a process for converting relatively ashfree solid polymer wastes to more valuable liquid, solid and gaseous products which comprises mixing rubber and/or plastic wastes at high temperatures in a refractory petroleum stream and catalytically cracking the mixture. However, this cracking process usually involves long cracking time and high capital cost; therefore, it is impractical by utilizing these conventional cracking processes to treat the waste rubber.

Compared with several other production processes, the present invention provides a process for producing fuel oil and gas by cracking waste rubber in a shorter reaction time than that of any previously known process, and, furthermore, overcomes the commercialization problem by having a lower capital cost.

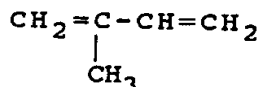
Currently available rubber can be classified into two types.

I. Natural Rubber

25 A. Natural rubber is made from the latex of rubber plants; it is firstly concentrated into a crude rubber of about 94% rubber by weight.

B. This crude rubber is a hydrocarbon of the formula:

30 2-methyl-1,3-butadiene or isoprene



35 C. It is then refined into secondary crude rubber, and which is softened between 130°C and 140°C, melted at 200°C, and drastically decomposed at 270°C.

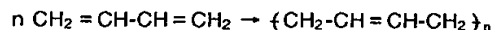
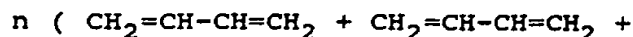
II. Synthetic Rubber

40 A. Synthetic rubber is produced by the catalysis and polymerization of petroleum oil.

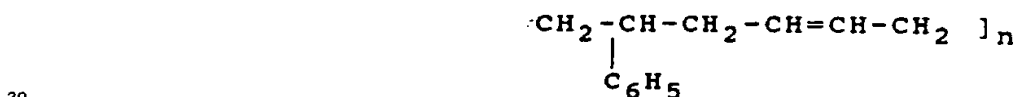
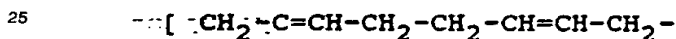
B. It is classified into diene, olefine, sulfide compound, organic dilicon compound, fluorine compound, ester, and vinyl compound. Diene (BR, SBR, and NBR rubber) and olefine (II R, EPM, and EPDM rubber) have been found to have more economical properties than the others, with rapid reaction rates. The majority of diene are 1,3-butadiene and isoprene. The majority of olefine are isobutylene, ethylene and propylene.

45 The materials currently used for tyres and wire insulators are mainly either natural rubber or synthetic rubber (in the latter case preferably either diene or olefines). The constituents are variably proportioned for specific use. Additives, such as antiager, preservatives, fillers, coloring agents, etc., may also be incorporated into rubber products.

50 Rubber manufacturing is primarily a process of polymerization and copolymerization.

I. Polymerization10 II. Copolymerization

20 styrene initiator



These compounds are polymerized and copolymerized as a result of the  $\pi$  bond's affinity for electron, forming -C- carbonium, thereby reacting with free radicals more rapidly.

## SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide a novel process for treating waste rubber.

40 A further object of this invention is to provide a novel process for producing fuel oil and gas by cracking waste rubber with a suitable catalyst under specific temperature and pressure conditions.

Another object of this invention is to provide a novel process for producing fuel oil and gas by cracking rubber, comprising the reaction of selected catalysts with waste rubber, wherein the catalysts are composed of CaO, Ni, XT-10, and traces of Nb and Ti. The waste rubber and catalysts are heated gently, softened at about 230°C, and stirred for about 1 hour at about 280°C. The pressure of the reactor is increased to 2 kg/cm<sup>2</sup>. The formed products are then filtered, condensed, and fractioned into light oil, heavy oil, and gas for respective storage.

Further objectives and advantages of the present application will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

55 The present invention relates to a process for producing fuel oil and gas by cracking waste rubber, comprising the reaction of 2-6 parts catalyst with about 40 parts waste rubber in a reactor. The catalyst is composed of 15%-25% by wt. of CaO, 40%-60% by wt. of Ni, 20%-40% by wt. of XT-10, and traces of Nb and Ti, and XT-10 is a mixture of one or more of the following groups: dolomite, garbbero, microcline, Muscovite, tourmaline, talc, graphite-silky mica schist, syenite, limestone in form of lens, limestone in

saccaroid form, magnetite, lime, limestone and porcelain clay or China clay. Preferably, the catalyst is composed of 20% by wt. of CaO, 50% by wt. of Ni, 30% by wt. of XT-10, and traces of Nb and Ti.

First, the catalyst and waste rubber are heated gently, softened at about 230 °C, and stirred for about 1 hour at about 280 °C; the pressure of the reactor is then increased to about 2kg/cm<sup>2</sup>. Gas products thus formed are then filtered, condensed, and fractioned into light oil, heavy oil, and gas for respective storage. The total reaction time is about 2 hours.

For convenience, the composition of the catalyst used herein is tabulated as follow:

Composition	%wt	Use
CaO	15-25	Active Agent
Ni	40-60	Auxiliary Catalyst
Nb	--	--
Ti	--	--
XT-10	20-40	Main Catalyst

The main and auxiliary catalysts, being cross-catalytic, increase the formation of free radicals, and thus reduce the energy of activation ( $E_{ac}$ ) and speed the reaction. Furthermore, under the condition of the required reaction temperature and by means of the catalyst, the carbon bonds are broken in the proper positions for re-arrangement to complete the cracking of the rubber.

The following example illustrates the invention.

#### EXAMPLE

400kg of waste rubber added with 30kg of the above-mentioned catalyst is placed in a reactor and gently heated to 230 °C. At this time, the blend begins to soften and melt. Then the mixture is stirred for 1 hour at 280 °C. When the temperature is elevated to 320 °C, CO<sub>2</sub> is released first, followed by fuel gas. At the same time, the pressure of the reactor is increased to 2 kg/cm<sup>2</sup>, and the gas products, filtered and condensed, then flow into a storage tank, later to be fractioned into light oil, heavy oil, and gas. The total reaction time is 2 hours.

#### Result

Reactant & Product Table				
Reactants		Products		
Waste Rubber	400kg	(1) gas	51.6kg	12%
Catalyst	30kg	(2) light oil	73.1kg	17%
		(3) heavy oil	86kg	20%
		(4) carbide slag	172kg	40%
		(5) metal wire	34kg	8%
		(6) slag	12.9kg	3%
Total	430kg		430kg	100%

The cracking procedure of the present invention uses the specific catalyst to complete the cracking of rubber within a period of 2 hours.

While the invention has been explained in relation to its preferred embodiments, it is to be understood that various modifications thereof will become apparent to those skilled in the art upon reading the specification. Therefore, it is to be understood that the invention disclosed herein is intended to cover such modifications as fall within the scope of the appended claims.

## Claims

1. A process for producing fuel oil and gas by cracking rubber, comprising the reaction of 2-6 parts catalyst with about 40 parts waste rubber in a reactor, wherein said catalyst is composed of 15%-25%  
5 by wt. CaO, 40%-60% by wt. Ni, 20%-40% by wt. XT-10, and traces of Nb and Ti, said XT-10 is a mixture of one or more of the following groups: dolomite, garbbero, microline, Muscovite, tourmaline, talc, graphite-silky-micaschist, syenite, limestone in form of lens, limestone in saccharoid form, magnetite, lime, limestone and porcelain clay or China clay; said catalyst and waste rubber being heated gently, softened at about 230 °C, and stirred for about 1 hour at about 280 °C, the pressure of the  
10 reactor being increased to about 2 kg/cm<sup>2</sup>; gas products thus formed being then collected.
2. A process as claimed in claim 1, wherein said gas products are further filtered, condensed, and fractionated into light oil, heavy oil, and gas for respective storage.
- 15 3. A process as claimed in claim 1, wherein the total reaction time is about 2 hours.
4. A process as claimed in claim 3, wherein said catalyst is composed of 20% by wt. of CaO, 50% by wt. of Ni, 30% by wt. of XT-10, and traces of Nb and Ti.

## 20 Patentansprüche

1. Verfahren zur Herstellung von Heizöl und Gas durch Cracken von Gummi, das die Reaktion von 2-6  
25 Teilen Katalysator mit ungefähr 40 Teilen Altgummi in einem Reaktor aufweist, wobei der Katalysator aus 15-25 Gewichtsprozent CaO, 40-60 Gewichtsprozent Ni, 20-40 Gewichtsprozent XT-10, und Spuren von Nb und Ti besteht, wobei XT-10 ein Gemisch aus einer oder mehreren der folgenden Gruppen ist: Dolomit, Garbbero, Mikrolin, Muskovit, Turmalin, Talk, Graphit-Seidenglimmerschiefer, Syenit, Kalkstein  
30 in Form von Linsenglas, Kalkstein in Saccharoidform, Magnetit, Kalk, Kalkstein und Kaolin oder Porzellanerde; wobei der Katalysator und der Altgummi schwach erhitzt werden, bei ungefähr 230 °C weich gemacht werden, und bei ungefähr 280 °C während ungefähr 1 Stunde gerührt werden, der Druck des Reaktors auf ungefähr 2 kg/cm<sup>2</sup> erhöht wird; und die so gebildeten Gasprodukte dann aufgefangen werden.
2. Verfahren gemäß Anspruch 1, bei dem die Gasprodukte weiterhin gefiltert, kondensiert, und zu  
35 Leichtöl, Schweröl und Gas fraktioniert werden zwecks getrennter Speicherung.
3. Verfahren gemäß Anspruch 1, bei dem die gesamte Reaktionszeit ungefähr 2 Stunden beträgt.
4. Verfahren gemäß Anspruch 3, bei dem der Katalysator aus 20 Gewichtsprozent CaO, 50 Gewichtsprozent Ni, 30 Gewichtsprozent XT-10, und Spuren von Nb und Ti besteht.

## 40 Revendications

1. Procédé de production d'huile combustible et de gaz par craquage de caoutchouc, comprenant la mise  
45 en réaction de 2 à 6 parts de catalyseur avec environ 40 parts de déchets de caoutchouc dans un réacteur, dans lequel ledit catalyseur est composé de 15% à 25% en poids de CaO, de 40% à 60% en poids de Ni, de 20% à 40% en poids de XT-10, et de traces de Nb et de Ti, ledit XT-10 est un mélange d'un ou de plusieurs des groupes suivants : la dolomie, le garbbero, la microline, la muscovite, la tourmaline, le talc, le graphite-micaschiste soyeux, la syénite, le calcaire sous forme de lentille, le calcaire sous forme saccharoïde, la magnétite, la chaux, le calcaire et le kaolin ou le China-clay; ledit  
50 catalyseur et lesdits déchets de caoutchouc étant chauffés doucement, s'amollissant à environ 230 °C et agités pendant environ une heure à environ 280 °C, la pression du réacteur étant augmentée à environ 2 kg/cm<sup>2</sup>; les produits gazeux ainsi formés étant ensuite recueillis.
2. Procédé selon la revendication 1, dans lequel lesdits produits gazeux sont davantage filtrés, condensés  
55 et fractionnés en huile légère, en huile lourde et en gaz en vue de leur stockage respectif.
3. Procédé selon la revendication 1, dans lequel le temps de réaction total est d'environ 2 heures.

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4. Procédé selon la revendication 3, dans lequel ledit catalyseur est composé de 20% en poids de CaO, de 50% en poids de Ni, de 30% en poids de XT-10 et de traces de Nb et de Ti.

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